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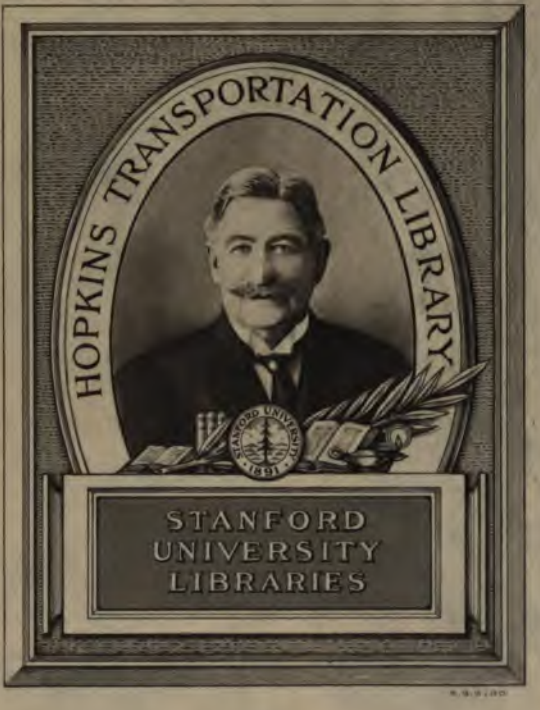
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MANFLIGHT.

PART I.

SEVERAL years ago I was a passenger on the old steamship "Constitution," bound from Panama to San Francisco. As the vessel was aged, and her engines and boilers were out of date, our progress was slow. To many this was a cause of annoyance, but, happily for me, I was quite without that feeling. The traveller may sometimes find himself in that comfortable frame of mind when, careless of the morrow, he is content to let each day pass quietly away. Such was my own mood at the time of which I write. Whether it was brought about by the consciousness of temporary freedom from the cares of a busy life, which must be met again at the journey's end, or whether it was the luxury of the tropical airs and placid seas which surrounded us, I cannot say. But of one thing I am sure, there is nothing that so quickens the imagination as the enforced idleness of a voyage over those summer seas.

So, as the time passed tranquilly away, I had nothing to do but to allow my mind to wander freely in the pleasant channels of thought suggested by the beauty of the surroundings. It was a pleasure to watch the shore, with its forests of palm-trees, and it was amusing to observe the shoals of porpoise which were constantly sporting about the ship; but we had still other travel-

ling companions in the innumerable flight of gulls which hovered about us and followed in our wake.

As I watched these birds day after day, I became fascinated with the grace and beauty of the creatures themselves, and with their marvellous evolutions. Our ship, with her ponderous engines, seemed to tremble with the toil of her own progress, while those creatures of the air, suspended upon their gracefully curved wings, kept pace with her, seemingly without effort.

When, in calm weather, I first began the study of the flight of birds, I thought that our feathered friends would be compelled to give up the chase when we encountered strong head winds. So true to its name is the Pacific, that I hardly hoped to have the opportunity of watching the gulls in a gale of wind; but one morning, coming on deck, we were off Point Concepcion, with a fierce wind blowing directly in our teeth, and above us and all around the gulls filled the air. Then I observed them closely, to discover, if possible, any apparent increase in their efforts to make headway; but there seemed on their part to be no effort. What a strange contrast between them and ourselves! Our ship struggled painfully to force her way against the blasts of wind and plunging head-seas, while the birds, on pinions which were apparently quite motionless, rose and dipped, thus conquering the gale.

Notwithstanding the long leisure for observation and study, I could not at that time solve the problem of flight; but those attempts were not quite without result; since then I reached one conclusion which I still hold firmly, namely, that the capability of a bird — or a

mechanical contrivance — of sustaining itself in the air depends not so much upon the exercise of a vast amount of power, or comparative lightness of the body sustained, as upon a *correct application of that power.*

I advanced no further than this; accompanying the idea, however, came the conviction that, if this view were correct, the time was not far distant when the brain of man, which had solved so many problems, would reach the solution of this one also. This idea was rich in its suggestiveness; then followed the thought of the wonders which our century has brought forth.

If, at its beginning, a man had stood before the people and declared to them that before a hundred years had elapsed, men would travel on wheels at the rate of a mile a minute; that they would cross the Atlantic Ocean in a week; that they would pierce mountains and sever continents; and that they would girdle the earth with wires through which the sound and articulation of the human voice could be conducted, — his listeners would have thought him mad indeed.

If he had added, "Men will navigate the air, as they now do the sea, before the century closes," the thought of the people would have been the same; but here, unfortunately, we of the present day stand on their plane.

When the dreamer of "Locksley Hall" says, —

> For I dipt into the future, far as human eye could see;
> Saw the vision of the world, and all the wonder that would be;
> Saw the heavens fill with commerce, argosies of magic sails,
> Pilots of the purple twilight, dropping down with costly bales;
> Heard the heavens fill with shouting, and there raised a ghastly dew
> From the nations' airy navies grappling in the central blue, —

we are too apt to regard him merely as a dreamer, but the time is coming when men will say, "Dreamer he was not, but prophet." It was with thoughts like these that I beguiled the days of that voyage, which are now only a pleasant memory.

At last we reached port, and I had no sooner landed in San Francisco than the duties of business again engrossed my attention, and for many a day the sea-birds of the smooth Pacific were forgotten.

Years after the period of which I have been writing, I happened to take up a publication of some English aeronautical society. My attention was at once attracted by the description of a machine for navigating the air. I cannot now give the details of this wonderful fabric, but only remember that the drawings impressed the beholder at once with the expanse of the sails, the apparent buoyancy of the metal vacuum-tanks, and with the bird-like appearance of the whole affair.

Closely reading the text which described the wonders of this projected vessel, with which the sanguine inventor hoped to revolutionize the locomotion of the world, I was amused at the credulity which he displayed. At this time came the recollection of the Pacific gulls, and my interest in aerial navigation was once again awakened.

When, years before, the matter had been a subject of thought, being at sea it had been impossible to gain access to books or periodicals, and consequently I had been in ignorance of what little progress had been made in the science of aerostation.

But the article in the English paper had aroused my

curiosity, and I immediately began an investigation of records. Everything which I could lay hands upon which had a bearing upon the subject was seized with avidity. The information thus obtained covered a period extending from the time of the Montgolfier brothers down to the present date.

As has been said, my observations of the Pacific gull had yielded little that was practical, except the great principle, which I believe to be a controlling one, namely, that it is not vast power, but a correct application of power, which will at last achieve the desired result. It caused me surprise to notice in these researches how many investigators ignored the principle referred to. Perhaps it was this that brought the thought that possibly I had made a step in advance, and this encouraged me to look more deeply into the matter. While I now attempt to carry the reader over the ground which I have traversed, I will not weary him with a long account of the history of air-navigation, because in a brief summary I can convey fully as clear an idea of present attainments. The classes of air-vessels which are to be enumerated will include not only those which have been constructed and used, but also those which have been projected upon paper.

Beginning with the simplest form, let us name under

Class I. Buoyant vessels. By this, meaning those fabrics which have only a lifting power; including both fire and gas balloons and vessels provided with vacuum tanks.

Class II. Winged machines. These are constructed

on the bird model and provided with motive power acting upon oscillating wings.

Class III. Screw machines.

Class IV. Aero-plane[1] machines, using the aero-plane in combination with one or more elements from preceding classes.

Class V. Combination machines, including those structures which combine two or more elements of the foregoing classes.

To the end that we may understand why practical air-navigation remains unaccomplished, let us glance at the faults of the machines which have been designed.

The buoyant vessels mentioned under the first class have given results which apparently show a slight progress in the right direction. Many years ago, when daring aeronauts learned to manipulate the balloon so that ascents and descents could be made with a tolerable degree of safety, men supposed that something had been gained; they seemed to think that the great aerial ships of the future had been launched, and thus a part of the problem solved: the remaining part, they thought, was to guide and propel this floating ship.

All these ideas have necessarily been abandoned. Prof. J. Bell Pettigrew, who has been a patient investigator into the science of aerostation, says: —

> The balloon is incapable of improvement; it is in no sense a flying-machine. It resembles the flying creature only in this, that it is immersed in the ocean of air in which it sustains itself. The mode

[1] By the term "aero-plane" is meant a thin, light, expanded structure intended to float or rest upon the air, and calculated to afford a certain amount of support to any body attached to it. — PETTIGREW.

of suspension is wholly different. The balloon floats because it is lighter than the air; the flying creature floats because it extracts from the air, by the vigorous, downward action of its wings, a certain amount of upward recoil.

The balloon is passive, the flying creature is active. The balloon is controlled by the wind, the flying creature controls the wind. . . . Weight, however paradoxical it may appear, is necessary to flight. Everything which flies is vastly heavier than the air. The inertia of the mass of the flying creature enables it to control and direct its movements in the air.

A little study shows us that buoyant vessels are entirely without value, and that the abandonment of them has been a step in advance.

We will now proceed to consider the second class of structures, — winged machines.

Some of the most eminent designers of flying-machines have spent years of labor in trying to construct an apparatus which should follow the bird model and accomplish artificial flight by the same means that are used in natural flight.

Some English scientists have gone into the most tedious and useless analyses of bird-flight with a view to its mechanical reproduction. It will not be difficult to show why these endeavors are useless. Nature is a good teacher, and the models which she furnishes have helped many an inventor to accomplish his task. But too close an imitation of nature is in many cases more of a hindrance than an aid. To illustrate this point, and to show the folly of attempting to construct winged machines, let us suppose the world to have wanted a locomotive. If the inventor had looked to nature for his model, he would probably have chosen, as being the

most powerful, the elephant. Then, if he followed the method of those who are trying to solve our difficulty by a study of wing movements, he would have constructed a vast machine with legs and levers!

Or, again, suppose the inventor who wished to propel a ship by its own motive power should have sought to apply that power in the same manner that nature applies it; he would have gone to the duck, and the product of his thought would have been a web-footed ship!

It is quite right for us to study nature that we may learn principles; but, as has been said, if we attempt to make the same application of power we do not progress.

In mechanics we find that the form of power which can be most readily utilized is rotary; so we may say that in mechanics the foundation of motion is revolution. But in the animal world revolution is unknown; all propelling power, whether of beast, bird, or fish, is applied by oscillatory movement. The reason for this is not far to seek. Living creatures are dependent upon the circulation of the blood. Revolution necessitates the existence of an independent revolving body.

As it is apparent that the mechanical duck and the artificial elephant would be useless, it will also be seen that mechanical wings can never lift us into the air.

If it were necessary to say more to show the folly of working on the bird model, I might call the reader's attention to the fact that the velocity of movement which will be necessary in our future air-ships would

cause the fabric to tear itself to pieces by the violence of its own vibrations.

When we first examine the many designs for machines coming under the third class, viz., screw machines, we begin to regard inventors as more rational; but here again we notice too close a following of the ideas suggested by a superficial study of the bird. The machines are all light in construction, with vast spreading surfaces of screw blades, and no suggestion of strength of build or power of action.

In class four — aero-planed machines — there is another false principle involved. Those who advocate the use of the aero-plane claim that, as we find that these passive surfaces assist the flight of the bird, therefore they should enter into the construction of the machine for mechanical flight. If our future air-ship were to be made with oscillating wings, the claims might not be unreasonable. The aero-plane lends aid to the flight of the bird because the action of the bird's wings is intermittent; the passive surfaces act while the active surfaces are idle; but it has been shown that the action of the future air-ship must be continuous, because no machine could be constructed of sufficient strength to withstand the strain of intermittent action; therefore, the introduction of a passive surface into a machine whose action is continuous would be useless, because it could only derive power by detracting from that of the continuously acting surface at the expense of the latter.

Concerning the fifth class of machines, it is only necessary to say that, since they are a combination of

the preceding classes, they are only a combination of faults.

We now come to the first great question, What must the future air-ship be?

To answer this question we must carefully look backward, that we may put aside the false ideas under which men have been laboring, and with still more care and patience we must look forward to frame theories which we can verify by practice.

Let us look into the problem, and in the first place determine what are the essential requirements of the practical air-ship.

It is evident that the first requirement is, foundation on which the weight of the air-ship may rest. It is equally plain that the second requirement is, power of self-propulsion ; and the third is, subjection to the control of the navigator.

In order to meet the first requirement we must have foundation for support ; since the vessel is to leave the solid earth, it is plain that this support must be found in the air itself. We have seen that all vessels of the buoyant class are useless, because our ship must conquer the wind, consequently the fabric which shall derive support from the air must be an active, and not a passive one. The next thing we have to ascertain is, upon what principle must this active supporter be constructed? It has been shown that we must quit following the bird model, and yet we must have a contrivance which, like the bird, will be able to convert the air into a solid foundation.

Having abandoned the idea of reaching this result by

oscillatory movement, we must therefore accomplish our end by a rotary movement.

If we hold firmly to this conclusion, we may consider that we have reached a milestone which marks the end of one great stage on our journey, and we are confident that we are well advanced in the right direction.

The revolving instrument of which we shall make use, must, of course, be the screw. As the use of the screw in water navigation has proved that it is the most efficacious instrument for attacking the yielding mass of water to obtain the desired recoil, so we shall find that it is the instrument of all others which we must use in our attack upon the unsubstantial air.

It seems preposterous at first to suppose that a revolving screw can lift an iron fabric into the air ; but it must be remembered that this seeming absurdity has been the black beast which has discouraged men from giving the matter the fair trial which it deserves.

The attempted air-ships which have made use of the screw have been constructed or designed upon false principles ; the breadth of expanse of the blades, and the lightness of the build, have been incompatible with the strength, power, and velocity which must characterize our future monarch of the air.

In the world's mechanical progress most of the knowledge which has been acquired concerning the power of the screw has been confined to the marine screw.

In the years which have elapsed since screw steamships were first launched, builders have had the

opportunity of ascertaining the laws by which these instruments act, and consequently have made modifications of form, size, and velocity, which make the instruments of to-day superior to those which preceded them.

The experiments by which these constructors of screws have profited have not required a sinking of money, because they have been of practical value, even before perfection was reached. But the world remains in ignorance of the possibilities of aerial screws, because no one has ever shown good reason for believing that the air-navigation problem can be solved in this way. Moreover, capitalists generally prefer to invest their funds in those things which have something to rest upon more substantial than air.

In the ground which has been looked over, we have seen that the science of aerostation has shown no practical results; it may be well at this point to consider how much theoretical progress has been made.

Prof. J. B. Pettigrew stands ahead of all others as a theorizer, and since no one has yet gone beyond theory, it is fair to say that he is nearer to the goal than any one else who has hitherto given the result of his thought to the public.

I have said that I consider his patient but tedious analyses of wing movement quite useless, so far as those studies have been intended to aid the solution of our problem. I believe that the results which he has obtained are valueless, for the reason that when we have once observed the Pacific gull in a gale of wind, and have become satisfied that a flying creature or contriv-

ance must have weight combined with power properly applied, and not mere lightness, then we have nothing more to learn from nature.

Nature does not teach us that we must attack the air with flattened surfaces, any more than the woodpecker teaches us the use of the hatchet; in either case it is man's instinctive mechanical knowledge.

Therefore when we consider that the movement with which we shall attack the air must be rotary, it is useless for us to attempt to learn from nature how to apply the power resulting from this movement. Professor Pettigrew has found a resemblance in winged movements to the motions of the blades of a screw; but the precise form of the screw-blades which will be best adapted to the needs of the air-ship will be best determined by experiment with actual screws.

Although there may be the same resemblance to the movements of screw-blades found in the fin movements of fishes that is found in the wings of birds, yet the inventors of the marine screw did not obtain their ideas from the fish. On the contrary, they took them from the primitive wood-screw. They reasoned that, since the screw would bore through wood, why not through water? Then they fashioned the blades as nearly as possible to the form of a perfect screw, that there might be as little waste, or "slip," as possible.

Let us carry this process of reasoning still further: If the screw will bore through wood and water with resistless force, why not through the air also?

If a fan held at arm's length is struck violently downward, you feel a certain amount of upward recoil; if

you repeat the experiment with still greater violence, you notice an increase in this recoil, showing that the greater the velocity of the movement the greater the recoil; and you know that it is true theoretically that you could lift yourself from your feet with the fan if your muscular power were sufficient. But while you are conscious of the lack of muscular power to do this, you are also aware that most of the power which you exert is wasted because of its being misapplied. The face of the fan is not of such a shape as to attack the air to the best advantage; and, more than this, the clumsiness of the system of levers composing your arm prevents the possibility of your imparting to the fan the same velocity which might be gained by a mechanical device applying the same amount of power by a different method.

It now becomes evident that we can reduce the waste of power to a minimum by giving to our aerial screw an enormous velocity; in fact, it is now easily seen that so attenuated an element as the air must be dealt with in this way.

Farther on reasons will be given for supposing that the lifting-power of the aerial screw can enable us to derive from the air a firm support; for the present let us suppose the theory to be correct, and proceed with the construction of our air-ship.

It has been said that the second requirement of our vessel will be power of self-propulsion. It is evident that here again we shall need the screw.

The third requirement is subjection to the navigator's control. We must have a helm and a rudder.

If we are to ascend with our ship, we must provide comfortable quarters for ourselves; therefore, as our vessel needs no keel, instead of laying one we will begin with the car. (D, see Fig. 1.)

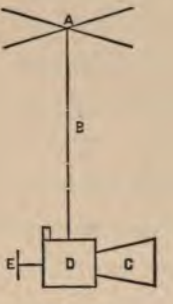

FIG. 1.

To lift the car we must have the screw (A) above it. As we cannot afford to waste power by carrying extra ballast, we must make our car itself serve the purpose. Therefore we must have our main shaft run up as far as is compatible with strength and lightness, so that the weight of the structure may hang upon the screw. If we use a single screw, when it is caused to revolve the recoil will make our car to spin about in an opposite direction; therefore we must contrive a way of steadying our vessel. This might be accomplished by a flat and broad-extending sail, but we must avoid all unnecessary surface in our ship, and, therefore, perhaps it will be well to use two screws instead of one, and have them revolve in opposite directions on the same centre by the use of a shaft within a shaft. Since the lift of these screws will cause great friction upon the shoulders, these must rest upon ball-bearings.

Having now, as we suppose, obtained our lifting power, we must have a screw for propulsion. Since the power required to give our craft an onward motion will be much less than that used for the upward, the vertical screw which we shall use may be much smaller than the horizontal one.

Now we project a horizontal shaft from our car and place upon it a screw (E) of moderate size.

The steering-apparatus is the next thing our vessel needs. Having no keel to steady her, the screw and rudder should be placed at opposite ends, and if we have the screw at the stern, our rudder should be placed well forward. When we consider that a slight inequality of form in the two lifting-screws would cause our car to revolve in the direction of the greatest power, we see the necessity of providing a guard against this; hence we extend a plane of canvas from stem to stern; whichever way the wind blows, the course of the ship relatively to the air will always be indicated by a line lying within this plane; therefore it can be only a slight impediment to her progress.

We have now our vessel built, and we would gladly step aboard, and, flying upwards and away, assert for the first time our supremacy of the air; but we are confronted by the momentous question, Will she fly?

Since our vessel is built only in imagination, we cannot answer the question by actual experiment; therefore we must endeavor to answer it by looking at probabilities.

Remembering our experiment with the fan held in

the hand, we can safely say that she will fly if we can give sufficient velocity to the lifting-screws.

Perhaps this statement seems to bring us back to the old idea that flight is possible when a motor can be constructed which shall be light enough.

But let us look at the matter in a new light and ask the question, Has the difficulty in the past been an excessive weight in the motor, or a misapplication of its power?

We cannot now assert that steam-power can accomplish our task; but, on the other hand, no man can state that it will not.

Why?

Because the long, careful, and costly series of experiments which alone can determine the power of aerial screws acted upon by steam-power have never been tried.

These experiments are well worth trying; but even if they fail, there are other resources left.

When we consider the crudeness of early steam-engines compared with the beautiful mechanisms of to-day, we see how successful men have been in the improvement of the machine, in the direction in which they have worked; namely, economy of fuel. But let it be remembered that this end has been sought after more than any other; and may we not suppose that if men worked as assiduously to secure economy of weight, there is reason to hope that they might be equally successful?

This matter of economy of weight in steam-engines has hitherto been one of comparative unimportance,

and inventors have had little to encourage them to study it.

The cost of iron is not sufficiently high to make it important that the stationary engine upon its brick bed should be light. In the locomotive a certain amount of weight adds to the power of traction; and in the case of marine engines, as the vessels must carry ballast of some sort, economy of space is more important than economy of weight.

We have good reasons for believing that the steam-engine can be made to supply us with more power with less weight than it does at present, perhaps by the use of aluminum.

Another important fact from which we may draw startling conclusions is that the steam-engine, with its boiler as it is to-day, exerts more power than its weight in horse-flesh can do; and we have good authority for stating that birds have no more muscular power than beasts in proportion to their weight. Therefore, the steam-engine being lighter than the bird in proportion to its power, we may draw the conclusion that if it could apply its power as economically as the bird, it could fly as well.

The first sewing-machine and the first locomotive were crude affairs, but they embodied the great principles which made improvement possible. So it is with the air-ship which we have projected. We have put aside all the useless complications which have stood in the way of aerial navigation, we have stripped off the hamper of the air-ships of the past, and have constructed the air-ship of the future. The machine will

be improved and modified, but if the air is ever conquered by man it must be by means of a fabric which shall depend upon the principles to be found in our craft.

The initial experiments which would determine whether or not steam-power can perform our work would not be costly. But should these experiments be successful, the continuation of them to a triumphant end would take large resources, but the money would not be wasted; for the simple experiments with which we should start would show conclusively whether or not success could crown our efforts in the end.

If, after all, we should find that steam is inadequate, then we must look to electricity. The progress in electrical science during the past decade has been so marvellous that no new invention can now surprise us. If a light storage battery can be devised, the first use of it must be made in aerostation.

Since the circumstances forbid us at present to make an actual voyage in our vessel, let us take an imaginary flight in the safe and snug craft. This shall be our trial trip. An open space in the park will be our best starting-place. As we approach the spot, we fear to trust our precious lives to the unknown contrivance which we see resting upon the ground, surrounded by a gazing crowd. But when we remember that Columbus risked his life, and sailed over dark and unknown seas because he felt the strength of his convictions, let us, with like fortitude, place our dependence upon the sustaining power of the screw.

We enter the car, scorning to notice the multitude of

doubting people who have come to see what to them is a mad experiment.

We look aloft at the thin, shining steel blades of our lifting-screws; we admire their graceful curves, and are impatient to see them in motion. Our engine is a model of compactness and power; the parts are of the finest quality of steel; the boiler is small, but, being constructed to bear an enormous pressure, we do not doubt its power.

The time has come for our great victory; the steam-gauge shows the requisite high pressure; with cool blood let us perform our work, for steady hands alone can give us control of our craft.

The steam is now gradually turned on, the blades begin to revolve with a smooth and noiseless motion, and yet we do not rise. But have patience, we must be deliberate; although our screws are revolving so rapidly that they are but blurs, yet we are only testing the smoothness of our running-gear, and this is but a tithe of the power we can exert.

All works well! With confidence we open wide the valve, and, like a vast humming-bird, our fabric lifts itself aloft. The crowd far below us does not cheer; it is thunder-struck; but, hardly noticing the people, we turn our attention to our craft.

We have not yet put in motion our propelling screw, and, as we mount to our high altitude, we are only drifting. A slight inequality between our lifters causes the ship to revolve slightly. The revolution is so slow that our plane of canvas does not check it, and although it causes us some giddiness, yet we are not

uneasy, for we know that when we have steerage-way the helm will give us absolute control. So now we start the engine which moves our propeller, and with the obedience of a slave the vessel begins to answer her helm.

More steam, and still more, we give to the propeller, till the little screw answers like a bee to the humming-bird aloft.

Again we look down; the city is far away, and we are speeding over fields and forests on the wings of the wind.

Away, away, through the wide, wide sky.

The woods which a few moments ago were far ahead are now passing rapidly beneath us; our velocity is appalling; we cannot estimate it, and the rushing of the wind against the car sounds like a great organ-pipe to which the iron stays, as they cut the air, whistle a piccolo accompaniment.

Now, having found our ship perfectly obedient to our wishes, we begin to wonder where we are and whither bound. With dismay we remember that we have no chart. Then we bethink ourselves that such a thing as an aerial chart is not known. We must see to it that the Government causes the country to be covered with land-marks to enlighten the wayfarers of the air, for, alas! the towns all look alike.

So, having lost our way, we must descend and look for a guide-post. We are over a forest, through it winds a road; surely there must be guide-posts along the way. We stop our propeller, and our headway,

which gradually slackens, still gives power to the helm. Fraction by fraction we close the valve which governs our lifting-screws, until the speed decreases so that we gently sink downward. At last, with the lightness of a feather, our faithful craft rests on mother earth.

As we step from our ship to the ground we feel profoundly thankful that our alighting has been so graceful, because we recall the story of the adventures of one Darius Green, and we remember that the moral of his tale was, "Take care how you light!"

PART II.

So much interest in the subject of manflight has recently been shown that I have been led to reprint the foregoing paper, which was first published in January, 1884.

The great problem naturally falls into three divisions: —

I. To overcome the attraction of gravitation.

II. To steer the machine.

III. To alight.

It is reasonable to suppose that the solution of the first part will be quickly followed by that of the other two parts. Of course all that is necessary for the solution of the first part is to make a correct application of the power of a sufficiently light motor.

Professor Langley, in the "Century" for September, 1891, says, "Engines have very lately been made for a special purpose, to weigh, together with a supply of fuel for a short flight, considerably less than twenty pounds to the horse-power, everything movable included." This being so, I believe that the first part of the problem is solved. The public does not care much about proofs figured out upon paper; what is needed at the present time is the ocular demonstration to the people that the air is a solid if you hit it hard enough, and that the

attraction of gravitation no longer stands in our way. When this is done, thousands of inventive geniuses will set their brains at work to devise ways of steering the machine and making a safe landing.

Perhaps the best way of doing this will be to take one of the engines which Professor Langley describes, and place it upon a platform like that of a light freight-elevator running between two guide-bars. Let the whole power of the engine be devoted to the driving of an elevated horizontal screw, made of very thin soft steel, at the highest speed which the strength of its materials will permit. Persuade a cockswain of one of the 'Varsity crews to sit on the platform and start the engine. When the engine is started, the platform, engine, boiler, and cockswain, lifted by the screw, will — I was going to say — rise. I can't say that, but I can say this, Professor Langley says he has made many thousand experiments, and if he will make this one more, I believe it will be successful; if it isn't, I hereby agree to find some one who will pay the cost of it, provided it is made according to plans which I will furnish.

We come now to the second part of the problem: to steer the machine. In the apparatus described in my article published in 1884 there is a screw for propulsion working on a horizontal axis. It now seems probable that this screw is superfluous, and that the suspending screw, or system of screws, is all that is needed.

When the vertical axis is slightly inclined the machine will take a horizontal course in the direction of such inclination, provided the speed of the screws can be so regulated as to keep the altitude reasonably constant.

The following diagram will give an idea of a better machine than the one described in 1884: —

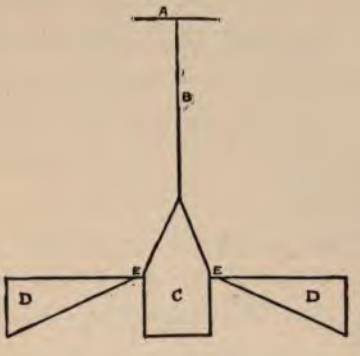

FIG. 2.

A represents a horizontal screw or system of screws; B, a vertical shaft or system of shafts; C, the car; DD, a pair of widely extended rudders, both fixed to a rock-shaft, EE. Of course, the whole fabric would need to be strengthened and made rigid by standing-rigging of steel wire, but it is not necessary to show this in the diagram. The whole machine will hang suspended from the screw, or system of screws, at A; that is to say, we hope it will.

When the machine leaves the ground the car will have a tendency to revolve. The rudders D D should be broad enough and should be extended far enough to check any inconvenient revolution. These rudders, working upon a rock-shaft, would probably enable the manflyer to incline the vertical shaft at will, and so direct the machine in a horizontal course. To move in any desired direction in the horizontal plane, a third

rudder would be necessary, this to be at right angles to the other two.

The third part of the problem is, to alight. We hope that the rudders D D can be so arranged that they will steady the machine, and that mechanics can devise a way of slowing down the engine with such extreme nicety that we can face up into the wind and come to earth like a feather; but, we do not know; it is the old Darius Green problem over again.

In the article by Professor Langley which has been referred to, and also in an article written by Mr. Maxim and published in the "Century Magazine" for October, 1891, much attention seems to be given to aero-planes.

In my 1884 article I tried to show the uselessness of aero-planes. Is it not evident that at the moment of starting or stopping, the aero-plane, being a passive surface, is nothing but a dead weight? Where is its efficacy? It is entirely from active surfaces that we must derive our support. These may be active while the car is at rest, passive surfaces never.

To have lifting power, the aero-plane must have an enormously rapid motion through the air; this at times it cannot have; so let us throw it away and substitute the screw.

We were taught in school the relation which the screw bears to the inclined plane. Take a piece of paper and cut it into a right-angled triangle. Let the hypothenuse represent a line running in Professor Langley's aero-plane. Take the paper and roll it around a pencil, starting with the base parallel with the axis of the pencil. Then you have the same line run-

ning in a spiral form and representing a line running in a screw surface, and you have your plane in a form where you can use it as an active surface while the car is at rest.

If you want to bore through the air, the best way is to set up your borer and bore.

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